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# The SPoRT-WRF: Evaluating the Impact of NASA Datasets on Convective Forecasts

**Bradley Zavodsky**

Danielle Kozlowski

Jonathan Case

Andrew Molthan

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transitioning unique NASA data and research technologies to operations



# Presentation Outline

Introduction/Motivation

SPoRT-WRF Version 1 Overview and Procedure

SPoRT-WRF Version 1 Quantitative and Qualitative Results

Feedback on SPoRT-WRF Version 1 at 2011 HWT EFP

SPoRT-WRF Version 2 Development

Summary



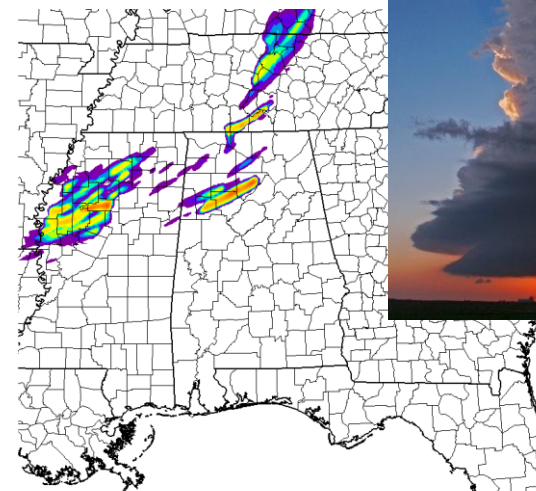
Photo by K. McGrath



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# Introduction/Motivation

- SPoRT focuses on improvements to short-term, regional weather forecasts using unique NASA products and capabilities
- Accurate forecasting of convection (timing, intensity, mode, location) is forecast challenge for regional/local scale modeling
  - WFOs cite this as main forecast challenge in their local modeling efforts
  - SPC/NSSL have revolved their Spring Experiment around the “convection-in-models” forecast challenge for many years
  - SPoRT’s data sets provide additional information on factors that contribute to convection in NWP models
- Since SPoRT’s inception, research projects have examined the sensitivity of a individual dataset or capability
- SPoRT-WRF combines all datasets and capabilities into one real-time modeling system for testbed evaluation by forecasters

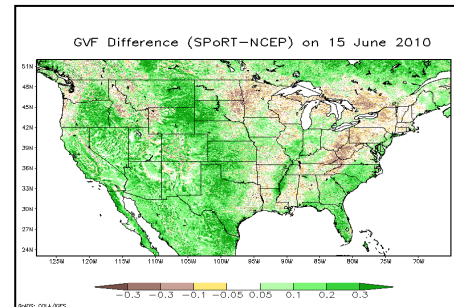




# SPoRT-WRF V1 Background

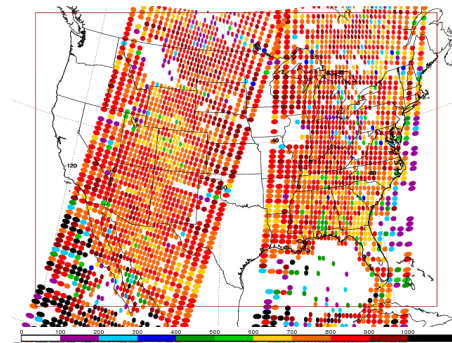
- Identical configuration to National Severe Storms Laboratory (NSSL) WRF used operationally by SPC
  - Same WRF core (ARW), domain (CONUS), resolution (4-km), and physics options (convective allowing)
  - Except for 12-km NAM-218 used for initial and boundary conditions
- NASA Unified WRF (NU-WRF) with unique NASA datasets and capabilities:

- SPoRT SST Composite
  - 2-km resolution
  - Generated twice daily
  - Provides details that allow model to account for over-ocean fluxes and seabreeze forecasting

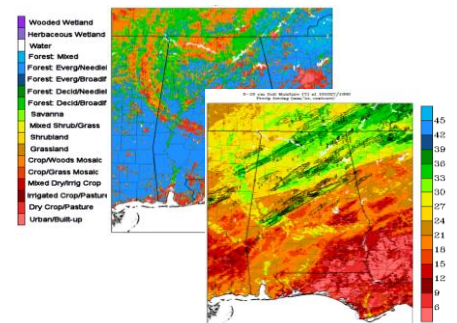
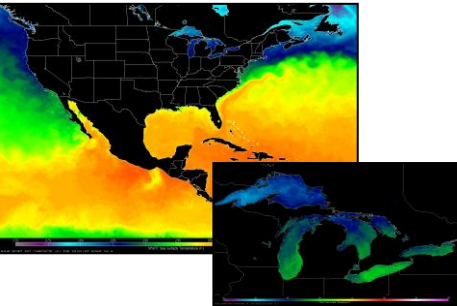


- MODIS GVFs
  - 1-km resolution
  - Generated once daily
  - Replaces coarse climatology to produce weather-of-the-day details that affect energy fluxes for weakly-forced convection

- LIS
  - 3-km resolution
  - Run once daily (available every 3 hours)
  - Uses precipitation data and vegetation to predict soil characteristics that shape energy fluxes for weakly-forced convection



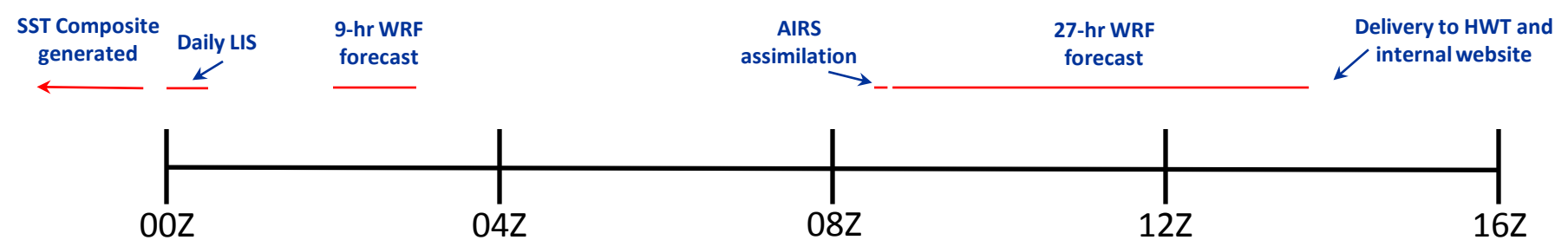
- AIRS Profile Assimilation
  - 45-km resolution
  - Assimilated once days (available twice daily)
  - Enhances upper-air analysis at asynoptic times to provide information on atmospheric moisture and stability



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# SPoRT-WRF V1 Procedure

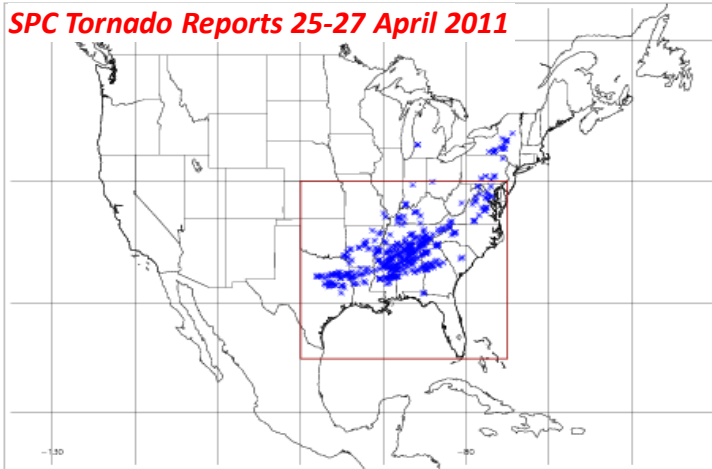
- Initialized each day at 0000 UTC
- Surface datasets integrated into SPoRT-WRF at initialization using a modified version of the NU-WRF Preprocessing System (WPS)
  - MODIS GVFs are incorporated into the system through the LIS
  - LIS is run offline once per day to provide land-surface information for model
  - SPoRT SSTs are generated offline and brought in as a replacement for the RTG SST product
- AIRS profiles assimilated using WRF-Var with 9-h forecast as background
- Forecast runs additional 27 hours (total of 36) producing forecast output every hour
- Files are postprocessed using the WRF Postprocessor (WPP) with GRIB1 files sent to HWT and model output images displayed on internal SPoRT website



**Current Daily SPoRT-WRF Timeline**

# Impact on April 25-27 Forecasts

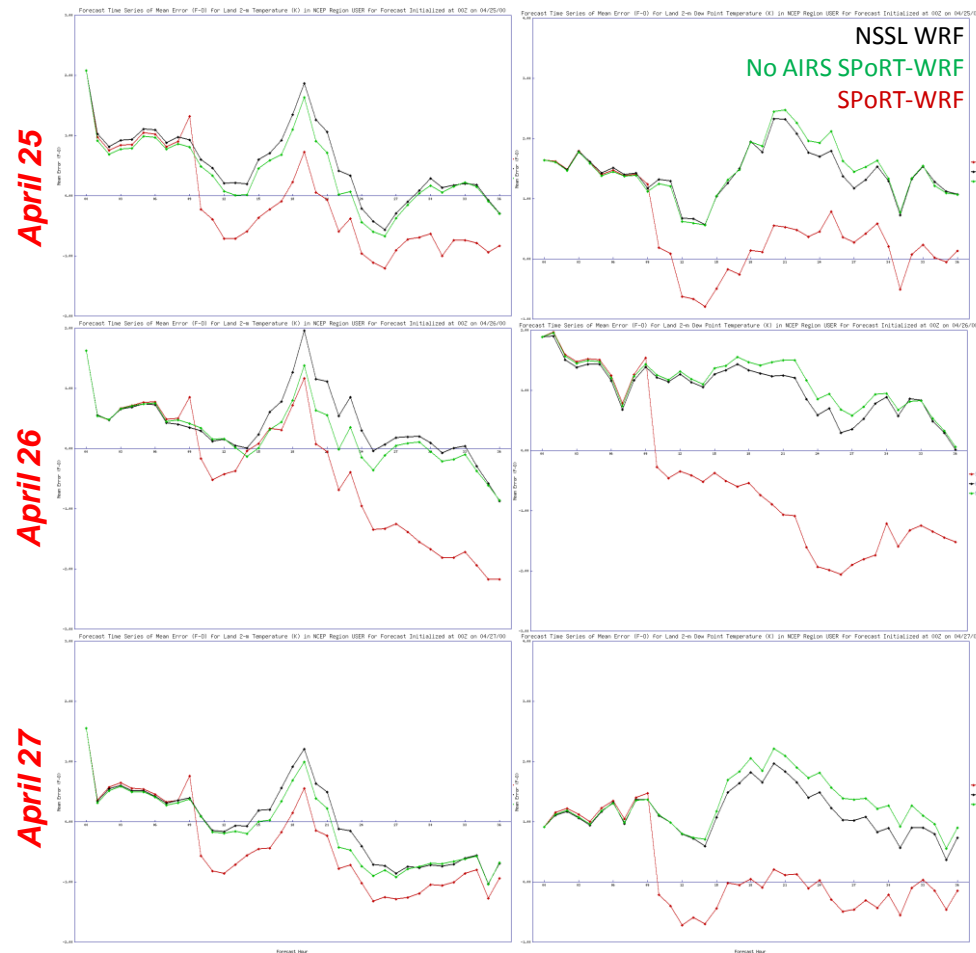
SPC Tornado Reports 25-27 April 2011



- MET evaluation tools used to produce a statistical evaluation of surface characteristics comparing SPoRT-WRF to NSSL-WRF for historic tornado outbreak
- **Conclusion**: SPoRT-WRF tends to have a cool and dry bias for 2-m T and  $T_d$ 
  - Largest impact from AIRS profiles
  - LIS/GVFs slightly cool and moisten
  - Likely little impact from SSTs for these strongly-forced non-coastal storms

2-m Temperature

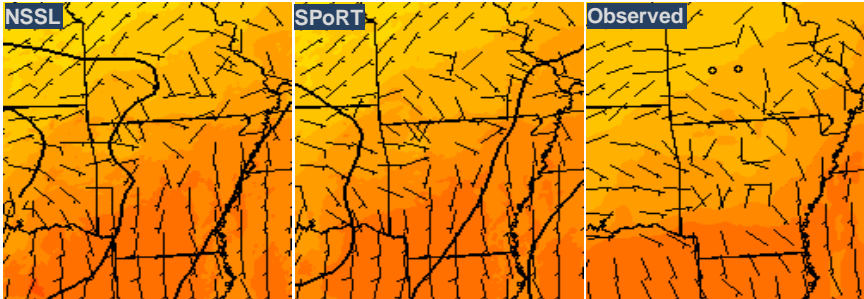
2-m Dew Point



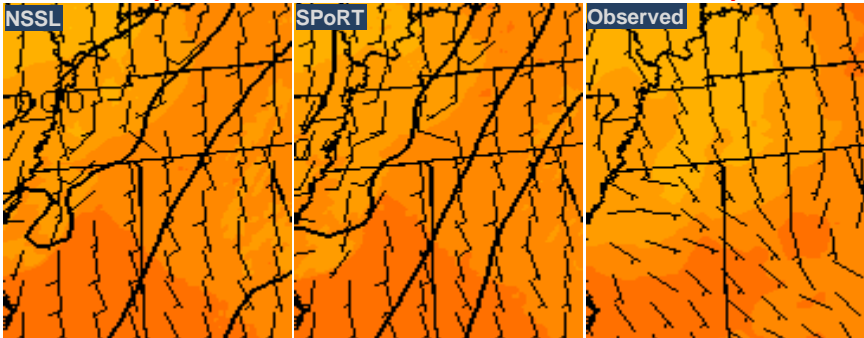
Mean Forecast Error (F-O) Compared to METAR, SAO, and Mesonet Observations

# Qualitative Forecast Comparison

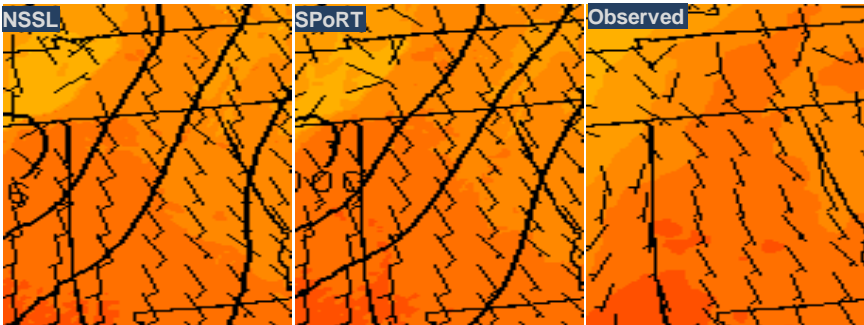
*2-m Temperature and 10-m Winds at 0900 UTC 25 April 2011*



*2-m Temperature and 10-m Winds at 0900 UTC 26 April 2011*



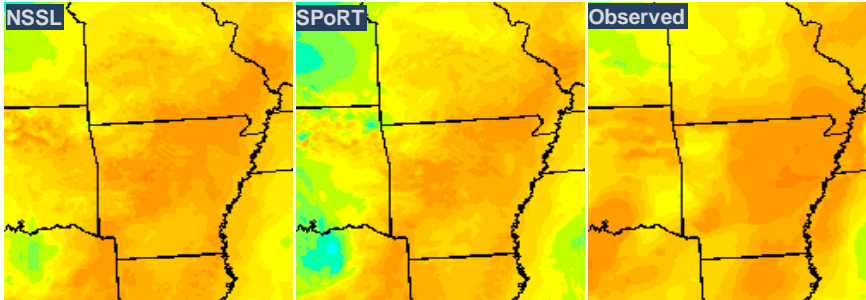
*2-m Temperature and 10-m Winds at 0900 UTC 27 April 2011*



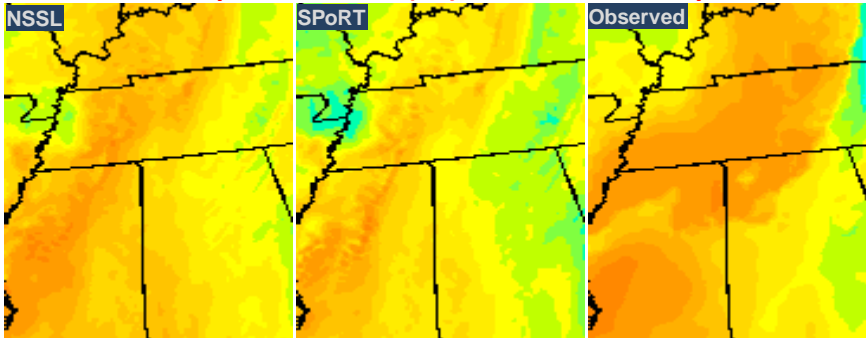
- Evaluated reflectivity at selected forecasts for historic 25-27 April 2011 tornado outbreak across the SEUS
- Tracked reflectivity differences back to initial conditions in surface parameters
- **Conclusions:**
  - 25 April: SPoRT has slightly cooler 2m temperature than NSSL, but is more consistent with RUC analysis
  - 26 April: SPoRT has very small differences in 2m temperature from NSSL; both are slightly warmer than the RUC
  - 27 April: SPoRT slightly warmer than NSSL; RUC analysis is cooler than both; SPoRT similar to NSSL for 10m wind; both forecasts stronger southerly winds than RUC

# Qualitative Forecast Comparison

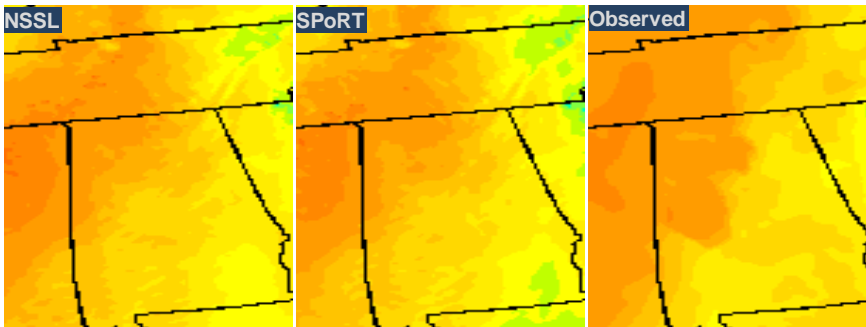
*Total Precipitable Water (in.) at 0900 UTC 25 April 2011*



*Total Precipitable Water (in.) at 0900 UTC 26 April 2011*



*Total Precipitable Water (in.) at 0900 UTC 27 April 2011*



- Evaluated reflectivity at selected forecasts for historic 25-27 April 2011 tornado outbreak across the SEUS
- Tracked reflectivity differences back to initial conditions in surface parameters

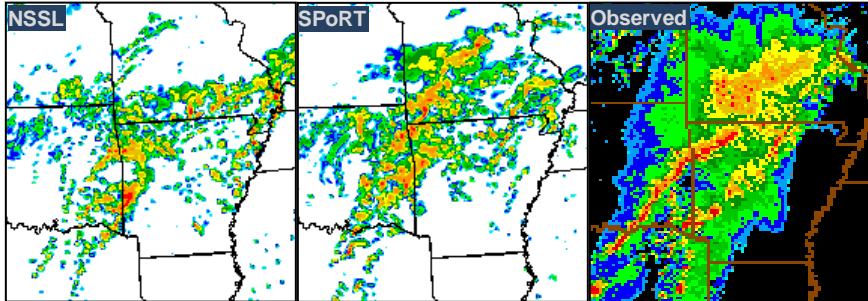
- **Conclusions:**

- 25 April: SPoRT is drier than NSSL and RUC analysis
- 26 April: SPoRT is drier than NSSL; RUC analysis is much more moist over N MS and W TN and drier over E TN and E KY
- 27 April: SPoRT is slightly drier than NSSL; both are drier than RUC analysis

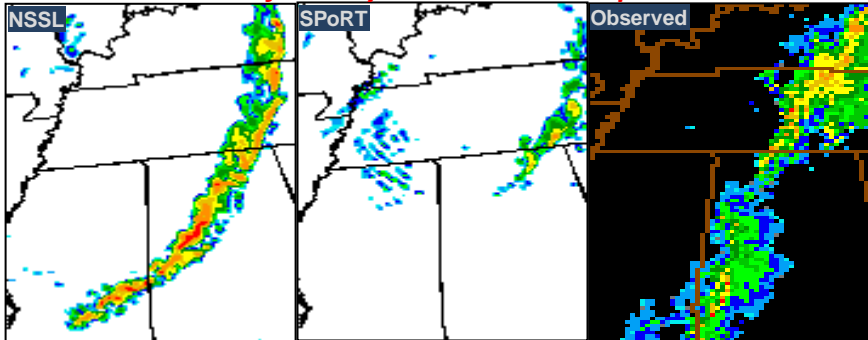


# Qualitative Forecast Comparison

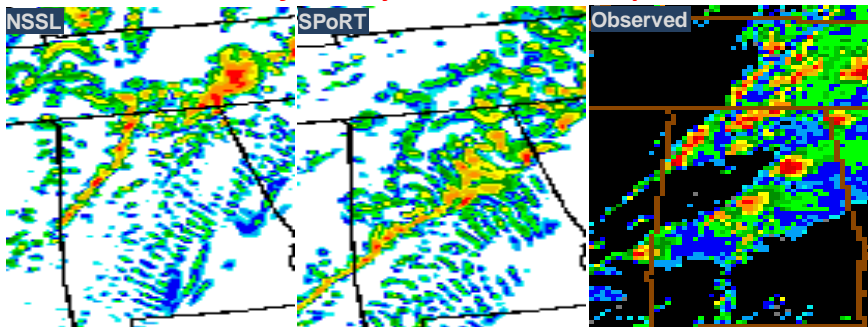
1-km Reflectivity at 2100 UTC 25 April 2011



1-km Reflectivity at 1500 UTC 26 April 2011



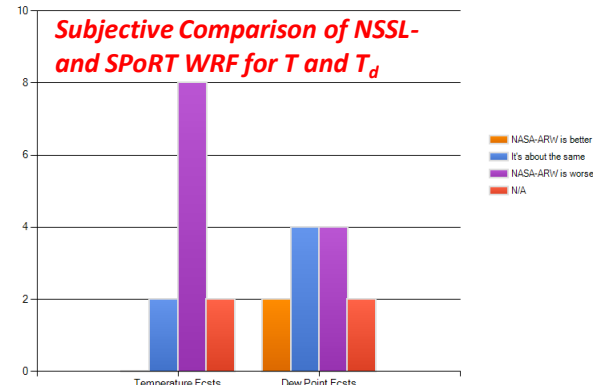
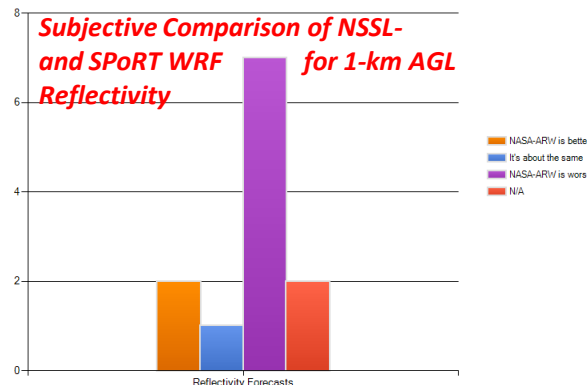
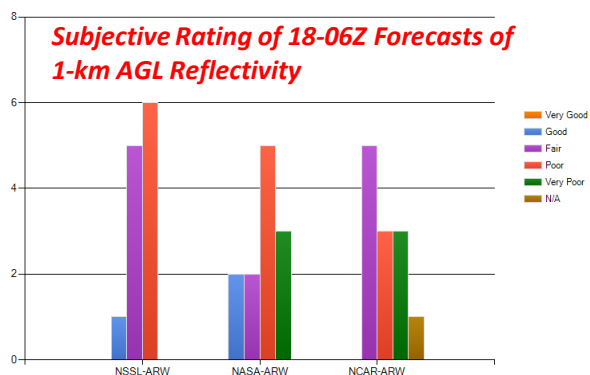
1-km Reflectivity at 0000 UTC 28 April 2011



- Evaluated reflectivity at selected forecasts for historic 25-27 April 2011 tornado outbreak across the SEUS
- Tracked reflectivity differences back to initial conditions in surface parameters
- **Conclusions:**
  - 25 April: SPoRT has more convection with two-band feature in AR/OK/MS tri-state area; more closely matches the observed reflectivity than NSSL
  - 26 April: SPoRT removes almost all precipitation from MS and AL with some convection over NE TN; NSSL produces strong squall line from E KY to E MS; observed reflectivity show precipitation but no convection
  - 27 April: SPoRT displaces cold front too far SE compared to both NSSL and observed reflectivity

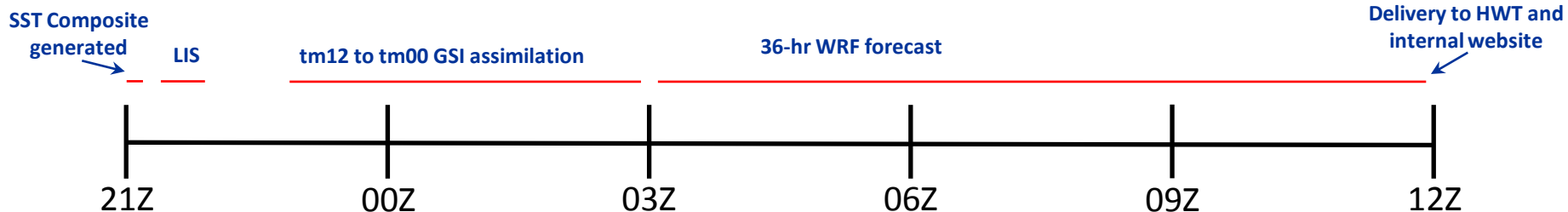
# Feedback from Spring Experiment

- NOAA HWT's Spring Experiment ran from 9 May – 10 June 2011
  - This year's EFP focused on severe weather, QPF, and CI forecasting
  - Brings together modelers and operational forecasters to subjectively evaluate model performance and discuss the strengths and limitations of regional models and how they should be used operationally
- Each day, participants evaluated a number of regional models
  - SPoRT-WRF was evaluated for 12 days by the severe weather group
  - SPoRT-WRF evaluated against NSSL-WRF and an NCAR-WRF
- Overall feedback was that the SPoRT-WRF was too cool and dry and suppressed convection (some good; some bad)
  - Similar tendency to 25-27 April evaluation
- SPoRT-WRF performed comparably to NCAR-WRF and worse than the NSSL-WRF



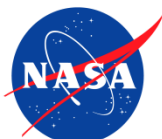
# SPoRT-WRF V2

- Feedback from research, testbed activities, and operational users improve model
  - AIRS profiles being assimilated in a start/stop methodology results in “shock to the system” imbalances that are never totally corrected
- Development of Version 2 of the SPoRT-WRF is completed for dissemination to 2012 EFP
  - Continuous (cycling) assimilation using Gridpoint Statistical Interpolation (GSI) with AIRS and IASI thermodynamic profiles, conventional, and other satellite radiances
  - Initialization of LIS during each cycle with improved precipitation forcing using CMORPH climatology product
  - Integration of USGS eMODIS GVF product
- Science questions to be pursued in 2012:
  - What impacts do the NASA datasets and model options have on convective forecasts?
  - How well does the SPoRT-WRF perform (both qualitatively and quantitatively) against other operational models?
  - Which individual components of the SPoRT-WRF have the largest impact on the performance?



***Planned 00Z Initialized SPoRT-WRF Timeline***

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# Summary

- SPoRT seeks to improve short-term, regional weather forecasts using unique NASA products and capabilities
- SPoRT has developed a unique, real-time configuration of the NASA Unified WRF (ARW) that integrates all SPoRT modeling research data
  - 2-km SPoRT SST Composite
  - 3-km LIS with 1-km GVFs
  - 45-km AIRS retrieved profiles
- Transitioned this real-time forecast to NOAA's HWT as deterministic model at EFP
- Feedback from forecasters/participants and internal evaluation of SPoRT-WRF shows a cool, dry bias that appears to suppress convection likely related to methodology for assimilation of AIRS profiles
- Version 2 of the SPoRT-WRF will premier at the 2012 EFP and include NASA physics, cycling data assimilation methodology, better coverage of precipitation forcing, and new GVFs



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